11.1

Claims

Claim 1 (amended)

I Claim:

A method for <u>making</u> [improving accuracy in] an implement <u>with improved accuracy</u> for measurement or control of a physical quantity by canceling out error due to an interfering noise N so as to provide an error corrected output V_C, sensitive to a signal input I, which includes the steps:

find or construct a sensor with an output V which has a signal to noise ratio SNR which changes substantially when the condition of an operating parameter Q is selectively modulated,

provide means whereby said output V of the said sensor in a higher said SNR state due to a condition of said operating parameter Q is combined with said output V of said sensor in a lower said SNR state due to a different said condition of said operating parameter Q, and

adjust said combined so that the said noise N mostly cancels but said sensor continues to have a good gain for said signal input I.

11.2

Claim 2

A method as claimed in claim 1, wherein said input I and said noise N are conditioned, or generally change by only a small amount during the time duration of one full operating cycle of change of said condition of said operating parameter Q.

11.3

Claim 3

A method as claimed in claim 1, wherein said sensor comprises at least two said sensors or a composite sensor having at least two sectors, and wherein each one of said two sensors or said two sectors operates full time at a different said condition of said operating parameter Q,

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so that there is thereby no need to have a short operating cycle time and no need to condition said input I and said noise N or require that they be generally constant over said one full operating cycle.

11.4

Claim 4

A method as claimed in Claim 1 wherein said sensor is a non-contact ammeter which incorporates at least one Hall device associated with a magnetic core SQ.

11.5

Claim 5

A method as claimed in Claim 1 wherein said sensor is a non-contact ammeter which incorporates at least one Hall device associated with a magnetic core SQ, and

wherein said operating parameter Q is the magnetic reluctance of said magnetic core SQ.

11.6

Claim 6

A method as claimed in claim 1 wherein said sensor is a non-contact ammeter which incorporates a Swain type sense coupling winding N_s wound on a core SQ.

11.7

Claim 7

A method as claimed in claim 1 wherein said sensor is a non-contact ammeter which incorporates a Swain type sense coupling winding N_s on a core SQ, and wherein said operating parameter Q is the peak current I_{sm} in said sense coupling winding N_s.

11.8

Claim 8

An implement with a sensor for measurement or control having an output V which changes when a desired signal input called I, changes,

and also wherein said output V of said sensor changes so that it has an error when an interfering noise source called N changes,

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said signal I and said noise N required to be inherently or conditioned to be largely constant in magnitude and direction for a time duration here called T_{A+B},

and means are provided to largely correct said error while preserving said input at an output of said implement here called V_c, and

said sensor is further chosen or constructed so that it has the essential characteristic that when the condition of an operating parameter Q is changed by a selective modulator, the sensitivity of said output V to said signal I is altered substantially differently from the sensitivity of said output V to said noise N in a manner called selective modulation;

more particularly, in said sensor said output V change per unit signal input I change is here called gain g, i.e.,

$$g \equiv \frac{\delta V}{\delta I}\text{ , and}$$

said output change per unit noise change is here called noise sensitivity Ψ,

defined as the change in said output per unit change in said noise, all divided by said gain, i.e.,

$$\Psi \equiv \frac{\delta V / \delta N}{g}\text{, and}$$

said operating parameter Q has at least two conditions here called M_A and M_B which are provided by means enabling, and

a timing means is provided with at least two states Ⓐ and Ⓑ having a total cycle time equal to or less than said T_{A+B}, and arranged to coordinate the action of said modulator,

means are provided whereby said output V is available as output V_A when in said condition M_A in said state Ⓐ and also said output is available as output V_B when in said condition M_B in said state Ⓑ,

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means are provided for combining said output V_A and said output V_B so that said noise N is largely canceled at said implement output V_c, and good gain g remains so that said implement output V_c is well responsive to said input I,

said means for combining constructed to accomplish much the same result as the following example:

means are provided for dividing said output V_A by divisor factor here called η, and

means are provided for subtracting said V_A divided by said η from said V_B to form a difference, which is the error corrected difference V_c, and

also, during said state Ⓐ said gain g has the value g_A, and said noise sensitivity Ψ has the value Ψ_A;

and further, during state Ⓑ ; said gain g has the value g_B, and said noise sensitivity Ψ has the value Ψ_B;

the ratio of said g_B divided by said g_A is called G, i.e.,

$$G = \frac{g_B}{g_A},$$

and we herein use the symbol ß for the ratio of said Ψ_B to said Ψ_A, i.e.,

$$ß = \frac{\Psi_B}{\Psi_A}, \text{ and}$$

for best results we choose or construct said sensor and build said selective modulator conditions M_A and M_B so that said sensor has the essential characteristic that said noise sensitivity ratio ß is substantially less than said gain ratio G, i.e.,

$$ß << G;$$

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where an example of a practical case is

$$\beta = \frac{1}{2}, \text{ and}$$

$$G = 1.04, \text{ and}$$

where said factor η is the ratio of said V_A before said division to that after said division, and

wherein said factor η usually has a value close to $\frac{1}{\beta}$, i.e.,

$$\eta\beta = 1; \text{ approximately, and}$$

said difference V_c comprising a reduced but still useful component of said signal but much less of said noise because the said noise in said V_B was largely canceled by subtracting said $\frac{1}{\eta}$ part of said noise in said V_A,

so said difference V_c is what is wanted; an output sensitive to said input I but with said noise N largely canceled.

11.9

Claim 9

An implement with a sensor as claimed in claim 8 wherein said sensor is a non-contact current sensor.

11.10

Claim 10 (amended)

a method <u>for constructing apparatus</u> for correcting an error due to an interfering noise N in the output V of a sensor for measuring or controlling a physical quantity such as an electric current, temperature, pressure, etc., by the process here called selective modulation, including but not limited to:

said sensor being chosen or manufactured so that it has the essential characteristic defined in the following terms:

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said output V changes in response to a change in a desired signal input I and has a gain g which is defined as the ratio of said change in V divided by said change in I, i.e.,

$$g \equiv \frac{\delta V}{\delta I},$$

where said δV represents a partial derivative i.e., a small change in said output V produced by a small change in said I represented by said δI, it being understood that all other variables are held constant, and also

said output V also changes when there is a change in said noise N, i.e., said output V has a sensitivity to said noise N, here called Ψ and defined so that it is referenced to an equivalent of said input I by said gain g, i.e.,

$$\Psi \equiv \frac{\delta V / \delta N}{g}$$

and wherein the signal to noise ratio SNR of said sensor is the inverse of said Ψ, i.e., $SNR \equiv \frac{1}{\Psi}$,

and

said sensor is also chosen or manufactured so that it has an operating parameter here called Q, the condition of which, when altered by selective modulation M, substantially modifies the value of said signal to noise ratio SNR, and

said method involves finding or constructing said sensor having said essential characteristic within the bounds of practical values or conditions of said selective modulation M so that said error correction is useful, an example being;

said M has values $M_A = 20$ and $M_B = 50$
said g has values $g_A = 10$ and $g_B = 11$
said Ψ has values $\Psi_A = 35$ and $\Psi_B = 14$

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Then the ratios of said values are:

$$\frac{M_B}{M_A} = \frac{50}{20}, \quad \frac{g_B}{g_A} = \frac{11}{10}, \quad \frac{\Psi_B}{\Psi_A} = \frac{14}{35},$$
$$= 2.5, \quad = 1.1, \quad = 0.4,$$

Said $\frac{\Psi_B}{\Psi_A} = 0.4$ has been found to be useful and practical, and

the said method also involves providing means combining, usually by subtracting the said output when said selective modulation M has one or more values in a first range, all divided by a divisor factor here called η, from the said output when said M has one or more values in a second range;

where for said error correction the value of said η is usually close to said Ψ_A divided by said Ψ_B, as in the above example, but the value of η is adjusted for best said error correction,

$$\eta = \frac{\Psi_A}{\Psi_B}, \text{ approximately,}$$
$$= \frac{35}{14}$$
$$= 2.5; \text{ and}$$

The result of said combining which may be said subtracting is the desired said error corrected output V_c of said sensor; and

to be effective the result of said combining should be computed during a time when both said signal input and said noise are essentially constant, or so conditioned, or alternatively,

said combining can be done continuously, with practically no limitation on the duration of said time during which said signal and said noise are constant,

when two said sensors, here called sensor A and sensor B, with outputs V_A and V_B are used simultaneously with the said operating parameters Q set to operate continuously at different conditions M_A and M_B so that said sensor A has said SNR_A, and said sensor B has said SNR_B,

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said combining which may be said V_A is divided by said η; and said result of said subtracting V_c is made continuously available as said error corrected output.

11.11

Claim 11

A method as claimed in claim 10 wherein said sensor is a non-contact current sensor.

11.12

Claim 12

A method [and process] for constructing [and using] a sensor with reduced error for measurement or control including means:

a core of low magnetic reluctance material, here called SQ,

a coupling sense winding on said core having a number of turns, here called N_s,

an inverter having an output current, here called i_s, and an average said output current here called I_s, and also constructed such that said inverter has an operating parameter which is the peak value in either direction of said current, here called I_{sm},

a low input impedance means converting the said average value I_s of said inverter current to an output voltage here called V_c,

and said method includes:

[positioning] said core constructed so that it is optionally positioned to be influenced by a conductor carrying a signal current I to be measured;

said position being within the effective range of a magnetic field noise, here called N, causing at least part of an error in the form of a change in zero offset of said output voltage V_c, wherein

the sensitivity of said V_c to said noise N is here called Ψ, and defined as the change in said V_c due to a unit change in said noise N divided by a gain g, i.e.,

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$$\Psi \equiv \frac{\delta V_c / \delta N}{g}, \text{ where}$$

said g is defined as the change in said output V_c due to a unit change in said signal current I; i.e.,

$$g \equiv \frac{\delta V_c}{\delta I}, \text{ and}$$

said method also includes series connecting said N_s, said inverter, and said low input impedance means converting;

and adjusting said means, including said N_s and said I_{sm}, so that the change in said gain g is considerably less than the change in said noise sensitivity Ψ, as said noise sensitivity Ψ is reduced from a maximum to a value considerably less than said maximum, said reduced being accomplished by altering the value of said means, especially the number of turns on said winding N_s and the said peak inverter current I_{sm}, said altering being preferably in the direction of a greater value of the product of said N_s and said I_{sm},

and operating said sensor with said product of said N_s and said I_{sm} set so that said noise sensitivity Ψ is considerably reduced below said maximum,

thereby constructing and operating said sensor with said reduced error in zero offset due to said noise N.

11. 13

Claim 13

A Swain Meter type non-contact direct current ammeter with improved accuracy for measurement or control, which comprises:

a core, here called SQ, of low magnetic reluctance material,

a coupling sense winding, here called N_s, on said core SQ,

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an inverter with power supply, here called X, with output terminals with a current i_s flowing which has an average value I_s, and also a peak value I_{sm} which is an operating parameter, all of said currents flowing in either direction in said output terminals,

a low input impedance means converting said average current I_s to an average output voltage V,

a current carrying conductor carrying a signal input current I, which is to be measured or controlled, positioned so that said current I influences said core SQ, and

said core SQ is within the effective range of an interfering magnetic field noise, here called N, and

said coupling sense winding N_s series connected with said output terminals of said inverter X and said low input impedance means converting,

said operating parameter I_{sm} set to a substantially greater magnitude than the magnitude corresponding to the minimum signal to noise ratio, here called SNR, so that thereby the said SNR is considerably increased over said minimum, so that said non-contact ammeter has considerably greater accuracy in the presence of said interfering magnetic field noise N.

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11.14

I Claim:

Claim 14)

An improved Sensor for at least one of measuring or controlling,

having an output V responsive to a physical quantity I, and also

responsive to an undesired interference N,

the ratio of

the said responsiveness of the said output V to said physical quantity I

in relation to

the said responsiveness of said output V to said interference N

being defined as the Sensor's signal to noise ratio SNR,

which can be stated in symbolic form:

$$SNR \equiv \frac{\delta V / \delta I}{\delta V / \delta N}, \text{ where}$$

δV is a change in said output V,

δI is a change in said physical quantity I, and

δN is a change in said interference N; and also

said Sensor is at least one of found or constructed to have the Essential Characteristic that the said signal to noise ratio SNR is

substantially altered by Selective Modulation of an Operating Parameter Q, and

means enabling said Sensor to function in at least one of:

as a part of Machine, or

independently.

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11.15

15) An improved machine having a machine output V_c for at least one of measuring or controlling a physical quantity I,

including a sensor having an output V responsive to said physical quantity I,

and also responsive to an undesired interference N,

the ratio of the said responsiveness of the said output V to said physical quantity I

in relation to

the said responsiveness of said output V to said interference N being

defined as the sensor's signal to noise ratio SNR, which can be restated in symbolic form:

$$SNR \equiv \frac{\delta V / \delta I}{\delta V / \delta N}$$

where δV is a change in said output V;

δI is a change in said physical quantity I;

δN is a change in said interference N; and

also said sensor is at least one of found or constructed to have the essential characteristic that the said signal to noise ratio SNR is substantially altered by Selective Modulation of an Operating Parameter Q; and also

including means enabling the operations of at least one of said sensor and said Operating Parameter Q so that

said machine output V_c is more useful

as judged by at least one of the characteristics of said machine, including but not limited to;

accuracy,

sensitivity or

speed of response

per unit,

dollar cost,

power consumption,

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volume, or

weight.

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11, 16

16) An improved machine having a machine output V_c for at least one of measuring or controlling a physical quantity I,

including a sensor having an output V responsive to said physical quantity I,

and also responsive to an undesired interference N,

the ratio of the said responsiveness of the said output V to said physical quantity I

in relation to

the said responsiveness of said output V to said interference N being

defined as the sensor's signal to noise ratio, which can be restated in symbolic form:

$$SNR \equiv \frac{\delta V / \delta I}{\delta V / \delta N}$$

where:

δV is a change in said output V;

δI is a change in said physical quantity I;

δN is a change in said interference N; and

also said sensor is at least one of found or constructed to have the Essential Characteristic that the said signal to noise ratio SNR is substantially altered by Selective Modulation of an Operating Parameter Q;

and also including means whereby said output V of said sensor in a higher said SNR state due to a condition of said Operating Parameter Q

is combined with said output V of said sensor in a lower said SNR state due to a different said condition of said Operating Parameter Q,

and also including means enabling at least one of said sensor and said operating parameter Q and said combined so that

the said interference N is mostly removed from said machine output V_c but

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said machine output Vc has a good said responsiveness to said physical quantity I, so that said machine output Vc is more useful as judged by at least one of the characteristics of said machine, including at least one of but not limited to:

accuracy,

sensitivity or

speed of response

per unit,

dollar cost,

power consumption,

volume or

weight.

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11.17

17) A process for constructing an improved machine having a machine output V_c for at least one of measuring or controlling a physical quantity I by

canceling out an error in said machine output V_c due to an interfering noise N so as to provide an error corrected machine output V_c which is sensitive to said physical quantity I,

which includes at least the steps: find/construct, and provide; described as follows:

at least one of find ór construct a sensor with an output V which has a signal to noise ratio SNR which changes substantially when the condition of an Operating Parameter Q is selectively modulated; and

provide means whereby said sensor output V in a higher said SNR state due to a condition of said Operating Parameter Q is

combined with said sensor output V in a lower said SNR state due to an different said condition of said Operating Parameter Q; and

at least one of said combined, said Operating Parameter Q or said sensor are constructed so that the said error due to said noise N mostly cancels at the said machine output V_C, but

said machine output Vc is well responsive to said physical quantity I.

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11, 18

Claim 18

A process as claimed in claim 17, wherein said physical quantity I and said noise N during the time duration of one full operating cycle of change of said condition of said operating parameter Q are at least one of: changed by only a small amount naturally, or are so conditioned.

11, 19

Claim 19

A process as claimed in claim 17, wherein said sensor comprises at least one of: at least two said sensors or a composite sensor having at least two sectors, and wherein each one of said two sensors or said two sectors operates full time at a different said condition of said operating parameter Q,

so that there is thereby no need to have a short operating cycle time and no need to condition said physical quantity I and said noise N or require that they be generally constant over said one full operating cycle.

11, 20

Claim 20

A process as claimed in Claim 17 wherein said sensor is a non-contact ammeter which incorporates at least one Hall device associated with a magnetic core SQ.

11, 21

Claim 21

A process as claimed in Claim 17 wherein said sensor is a non-contact ammeter which incorporates at least one Hall device associated with a magnetic core SQ, and

wherein said operating parameter Q is the magnetic reluctance of said magnetic core SQ.

11, 22

Claim 22

A process as claimed in claim 17 wherein said sensor is a non-contact ammeter which incorporates a Swain type sense coupling winding N_S wound on a core SQ.

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11.23

Claim 23

A process as claimed in claim 17 wherein said sensor is a non-contact ammeter which incorporates a Swain type sense coupling winding N_s on a core SQ, and wherein said operating parameter Q is at least one of the peak current I_{sm} or the number of turns in said sense coupling winding N_s.

11.24

Claim 24

An improved machine as claimed in claim 16, wherein:

said physical quantity I and said interference N are required to be inherently or conditioned to be largely constant in magnitude and direction for a time duration here called T_{A+B},

said sensor is at least one of chosen or constructed so that it has the essential characteristic that when the condition of said operating parameter Q is changed by a selective modulator, the sensitivity of said output V to said signal I is altered substantially differently from the sensitivity of said output V to said noise N in a manner called selective modulation;

more particularly, in said sensor said output V change per unit physical quantity I change is here called gain g, i.e.,

$$g \equiv \frac{\delta V}{\delta I}\text{ , and}$$

said output V change per unit said interference change is here called noise sensitivity Ψ,

defined as the change in said output V per unit change in said interference N, all divided by said gain, i.e.,

$$\Psi \equiv \frac{\delta V / \delta N}{g}\text{, and}$$

said operating parameter Q has at least two conditions here called M_A and M_B which are provided by means enabling, and

a timing means is provided with at least two states Ⓐ and Ⓑ having a total cycle time equal to or less than said T_{A+B}, and arranged to coordinate the action of said modulator,

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means are provided whereby said output V is available as output V_A when in said condition M_A in said state Ⓐ and also said output is available as output V_B when in said condition M_B in said state Ⓑ,

said means combined are constructed so as to combine said output V_A and said output V_B so that said interference N is largely canceled at said machine output V_c, and said machine output V_c has a good said responsiveness to said physical quantity I,

at least one of said means for combining and said selective modulator and said Operating Parameter Q constructed to accomplish much the same result as the following example:

said means are constructed for dividing said output V_A by divisor factor here called η, and

said means are constructed for subtracting said V_A divided by said η from said V_B to form a difference, which is the error corrected difference V_c, which becomes the said machine output Vc,

also, during said state Ⓐ said gain g has the value g_A, and said noise sensitivity Ψ has the value Ψ_A; and further,

during state Ⓑ; said gain g has the value g_B, and said noise sensitivity Ψ has the value Ψ_B;

the ratio of said g_B divided by said g_A is called G, i.e.,

$$G = \frac{g_B}{g_A},$$

and we herein use the symbol ß for the ratio of said Ψ_B to said Ψ_A, i.e.,

$$ß = \frac{\Psi_B}{\Psi_A}, \text{ and}$$

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for best results we at least one of choose or construct said sensor and build said selective modulator conditions M_A and M_B so that said sensor has the essential characteristic that said noise sensitivity ratio ß is substantially less than said gain ratio G, i.e.,

$$ß << G;$$

where an example of a practical case is

$$ß = \frac{1}{2}, \text{ and}$$

$$G = 1.04, \text{ and}$$

where said factor η is the ratio of said V_A before said division to that after said division, and

wherein said factor η preferably has a value close to $\frac{1}{ß}$ i.e

$$\eta ß = 1; \text{ approximately, and}$$

said difference V_c comprising a reduced but still useful component of said physical quantity I but much less of said interference N because the said N in said V_B was largely canceled by subtracting said $\frac{1}{\eta}$ part of said N in said V_A,

so said difference V_c is what is wanted; a said machine output V_c responsive to said physical quantity I but with said interference N largely canceled.

11.25

Claim 25

A machine with a sensor as claimed in claim 24 wherein said sensor is a non-contact current sensor.

11.26

Claim 26 (amended)

A process for constructing machinery for correcting an error due to an interfering noise N in the output V_c of a machine for at least one of measuring or controlling a physical quantity I which is at least one of an electric current, temperature, pressure, etc., by the process here called selective modulation, including but not limited to the steps of providing a sensor having an output V and at

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least one of choosing or manufacturing said sensor so that it has the essential characteristic defined in the following terms:

said sensor output V changes in response to a change in said desired physical quantity I and has a gain g which is defined as the ratio of said change in V divided by said change in I, i.e.,

$$g \equiv \frac{\delta V}{\delta I},$$

where said δV represents a partial derivative i.e., a small change in said output V produced by a small change in said I represented by said δI, it being understood that all other variables are held constant, and also

said output V also changes when there is a change in said noise N, i.e., said output V has a sensitivity to said noise N, here called Ψ and defined so that it is referenced to an equivalent of said input I by said gain g, i.e.,

$$\Psi \equiv \frac{\delta V / \delta N}{g}$$

and wherein the signal to noise ratio SNR of said sensor is the inverse of said Ψ, i.e., $SNR \equiv \frac{1}{\Psi}$,

together with the step of at least one of choosing or manufacturing said sensor so that it has an operating parameter here called Q, the condition of which, when altered by <u>said</u> selective modulation M, substantially modifies the value of said signal to noise ratio SNR, and

said process includes at least one of [the steps] <u>means</u> of finding or constructing said sensor having said essential characteristic within the bounds of at least one of practical values or conditions of said selective modulation M so that said error correction is useful, an example being;

said M has values $M_A = 20$ and $M_B = 50$

said g has values $g_A = 10$ and $g_B = 11$

said Ψ has values $\Psi_A = 35$ and $\Psi_B = 14$

Then the ratios of said values are:

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$$\frac{M_B}{M_A} = \frac{50}{20}, \quad \frac{g_B}{g_A} = \frac{1.1}{10}, \quad \frac{\Psi_B}{\Psi_A} = \frac{14}{35},$$
$$= 2.5, \qquad = 1.1, \qquad = 0.4,$$

Said $\frac{\Psi_B}{\Psi_A} = 0.4$ has been found to be useful and practical; and

the said process also involves combining, by at least one of, but not limited to, the steps of subtracting the said output when said selective modulation M has at least one of one or several values in a first range, all divided by a divisor factor here called η; from the said output when said M has at least one of said values in a second range;

where for said error correction the value of said η is preferably close to said Ψ_A divided by said Ψ_B, as in the above example, but the value of η is adjusted for best said error correction,

$$\eta = \frac{\Psi_A}{\Psi_B}, \text{ approximately,}$$
$$= \frac{35}{14}$$
$$= 2.5 \text{ ; and}$$

the result of said combining which may be said subtracting is the desired said error corrected output V_c of said machine; and at least one of the steps of: obtaining or conditioning: obtaining the result of said combining as computed during a time when both said physical quantity I and said noise N are essentially constant; or conditioning both said I and said N so that they are at least one of held essentially constant during said combining; or said combining is done continuously, with practically no limitation on the duration of said time during which said signal and said noise are constant; and in the said step of said continuous combining using two said sensors, here called sensor A and sensor B, with outputs V_A and V_B, - used simultaneously with the said operating parameters Q set to operate said continuously at different conditions said M_A and M_B so that said sensor A has said SNR_A, and said sensor B has said SNR_B, and when said combining is said

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V_A divided by said η; and said result of said subtracting V_C is made continuously available as said error corrected machine output V_C.

11.27

Claim 27

A process as claimed in claim 26 wherein said sensor is a non-contact current sensor.

11.28

Claim 28 (amended)

A process for constructing [and using] a sensor with reduced error for at least one of measurement or control including means:

a core of low magnetic reluctance material, here called SQ,

a coupling sense winding on said core having a number of turns, here called N_S,

an inverter having an output current, here called i_S, and an average said output current here called I_S, and also constructed such that said inverter has an operating parameter which is the peak value in either direction of said current, here called I_{sm},

a low input impedance means converting the said average value I_S of said inverter current to an output voltage here called V_C,

and said process includes:

<u>means</u> positioning said core so that it is influenced by a conductor carrying a signal current I to be measured,

said position being within the effective range of a magnetic field noise, here called N, causing at least part of an error in the form of a change in zero offset of said output voltage V_C, wherein the sensitivity of said V_C to said noise N is here called Ψ, and defined as the change in said V_C due to a unit change in said noise N divided by a gain g, i.e.,

$$\Psi \equiv \frac{\delta V_C / \delta N}{g}, \text{ where}$$

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said g is defined as the change in said output V_c due to a unit change in said signal current I; i.e.,

$$g = \frac{\delta V_c}{\delta I}, \text{ and}$$

said process also includes series connecting said N_s, said inverter, and said low input impedance means converting;

and constructing said means, including at least one of: said N_s and said I_{sm}, so that the change in said gain g is considerably less than the change in said noise sensitivity Ψ, as said noise sensitivity Ψ is reduced from a maximum to a value considerably less than said maximum, said reduced being accomplished by altering the value of said means, including at least one of: the number of turns N_s on said winding or the said peak inverter current I_{sm}, said altering being preferably in the direction of a greater value of the product of said N_s and said I_{sm},

and operating said sensor with said product of said N_s and said I_{sm} set so that said noise sensitivity Ψ is considerably reduced below said maximum,

thereby constructing and operating said sensor with said reduced error in zero offset due to said noise N.

11, 29

Claim 29

A Swain Meter type non-contact direct current ammeter sensor with improved accuracy for at least one of: measurement or control, which comprises:

a core, here called SQ, of low magnetic reluctance material,

a coupling sense winding, here called N_s, on said core SQ,

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an inverter with power supply, here called X, with output terminals having a current i_s flowing which has an average value I_s, and also a peak value I_{sm} which is an operating parameter Q, all of said currents capable of flowing in either direction in said output terminals,

a low input impedance means converting said average current I_s to an average output voltage V,

a current carrying conductor carrying a signal input current I, which is to be at least one of: measured or controlled; positioned so that said current I influences said core SQ, and

said core SQ is within the effective range of an interfering magnetic field noise, here called N, and

said coupling sense winding N_s series connected with said output terminals of said inverter X and said low input impedance means converting,

said operating parameter I_{sm} set to a greater magnitude than the magnitude corresponding to the minimum signal to noise ratio, here called SNR, so that thereby the said SNR is considerably increased over said minimum, so that said non-contact ammeter has considerably greater accuracy in the presence of said interfering magnetic field noise N.

6-15-98.

11.30

I Claim:

Claim 30

An improved Non-Contact Current Sensor for at least one of measuring or controlling,

having an output V responsive to a signal current I, and also

responsive to a magnetic field noise N,

the ratio of

the said responsiveness of the said output V to said signal current I

in relation to

the said responsiveness of said output V to said magnetic field noise N

being defined as the Sensor's signal to noise ratio SNR,

which can be stated in symbolic form:

$$SNR \equiv \frac{\delta V / \delta I}{\delta V / \delta N}, \text{ where}$$

δV is a change in said output V,

δI is a change in said signal current I, and

δN is a change in said magnetic field noise N; and also

said Sensor is at least one of found or constructed to have the Essential Characteristic that the said signal to noise ratio SNR is

substantially altered by Selective Modulation of an Operating Parameter Q, and

means enabling said Non-Contact Current Sensor to function in at least one of:

as a part of a Machine, or

independently.

8-15-98

11.31

I Claim:

Claim 31

An improved Swain type non-contact direct current Sensor for at least one of measuring or controlling,

having an output V responsive to a direct current signal I, and also

responsive to an interfering magnetic field noise N,

the ratio of

the said responsiveness of the said output V to said direct current signal I

in relation to

the said responsiveness of said output V to said interfering magnetic field noise N

being defined as the Sensor's signal to noise ratio SNR,

which can be stated in symbolic form:

$$SNR \equiv \frac{\delta V / \delta I}{\delta V / \delta N}, \text{ where}$$

δV is a change in said output V,

δI is a change in said direct current signal I, and

δN is a change in said interferng magnetic field noise N; and also

said Sensor is at least one of found or constructed to have the Essential Characteristic that the said signal to noise ratio SNR is

substantially altered by Selective Modulation of an Operating Parameter I_{sm}, and

means enabling said Swain type non-contact direct current Sensor to function in at least one of:

as a part of a Machine, or

independently.

6-15-98